



Project Summary

Demonstration of a Paint Spray Booth Emission Control Strategy Using Recirculation/Partitioning and UV/Ozone Pollutant Emission Control

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The report describes in detail the source testing, construction, and data reduction/analysis activities that comprise the three phases of a technology demonstration program. Phase I consisted of a detailed baseline evaluation of several paint spray booths operated at the Barstow (California) Marine Corps Logistics Base to establish key operating parameters and air toxic emission profiles. This information was used to design a safe recirculation/flow partitioning system for the paint booths involved in the study to efficiently reduce the overall exhaust flow rate. Under Phase II, the necessary booth construction and retrofit modifications were made, and the air pollution control device was installed. The recirculation/flow partitioning system was tested extensively as part of the Phase III effort to ensure that the booths operated in accordance with health and safety standards mandated by the Occupational Safety and Health Administration (OSHA) and the National Fire Protection Association (NFPA).

This Project Summary was developed by EPA's National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate

report of the same title (see Project Report ordering information at back).

Introduction

The development of energy efficient and cost-effective strategies for controlling emissions of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) from painting processes is a key objective of the U.S. Environmental Protection Agency (EPA) and the Department of Defense (DoD). Both the EPA and the DoD have sponsored extensive research and development programs that focus on new approaches and innovative solutions to reduce the economic and operational impacts of controlling low concentration emissions from these sources.

In 1993, the U.S. Marine Corps (USMC) and the EPA's Air Pollution Prevention and Control Division (APPCD) collaborated in a joint effort under the Strategic Environmental Research and Development Program (SERDP) to develop a comprehensive technology demonstration program that combined innovative strategies for cost effectively controlling VOC emissions from USMC paint spray booths. The Marine Corps Logistics Base (MCLB) in Barstow, CA, was selected as the host site for the demonstration. The program involved the demonstration of a novel spray booth design which results in a significant reduction of exhaust volumes that must be treated.

The MCLB is a high production facility that generally operates year-round with two or three shifts per day. These operating conditions provide an ideal situation for demonstrating the viability of the paint spray booth design concept that was demonstrated in this program. The program provided an opportunity to conduct a realistic, long-term performance evaluation of the spray booth design. This summary provides some of the technical highlights for that program and of the paint spray booth design and operations.

Objective

The objective of the paint spray booth design and modification efforts was to reduce the cost of controlling emissions during painting. Based on previous DoD and EPA studies, the most straightforward and effective approach was to reduce the exhaust flow rate emitted from the paint application processes. Reducing the exhaust volume flow rate allows a corresponding reduction in the size, capacity, installation cost, and operating requirements of the emission control device. Further benefits gained with the reduction of exhaust volumes include the reduction of energy requirements and costs for the conditioning and movement of air.

Although the economic advantage of exhaust flow reduction is readily apparent, there are regulatory and code limits related to the health and safety aspects of ventilation system design. The design and operation of spray booths are regulated by OSHA and NFPA regulations and codes, respectively. Therefore, to validate that a recirculating spray booth can be designed, the key safety issues in the use of paint spray booths were researched and addressed during the program.

The Recirculation/flow partition booth design concept was successfully demonstrated in 1992 in a small paint booth at Travis Air Force Base (AFB) in California. However, the Travis AFB demonstration did not include an attached air pollution control system; rather, the exhaust was discharged to the atmosphere. These studies did, however, prove the capability of the concept.

Based on the successful results of the EPA/Air Force program, the USMC elected to implement a full-scale technology demonstration project that combined the recirculation/flow partitioning booth design with

an innovative air pollution control strategy that relies on ultraviolet (UV) light and ozone to remove VOCs and toxic air pollutants from the spray booth exhaust stream. For the demonstration, two existing spray booths were modified, and one newly designed and fabricated booth was completed using recirculation/flow-partitioning. The exhaust streams from these booths were discharged to the UV/ozone control.

Program Approach

The paint spray booth demonstration program was conducted in three phases.

Phase I - Evaluation of existing Barstow paint spray booth operations

The first phase of the program completed baseline characterization studies of the paint booths targeted for modification. The baseline characterization data were used to show that the post-modification booth environment was not degraded from pre-modification conditions. A second objective was to develop the design parameters for the booth modifications.

Phase II - Recirculation/flow partition system design and installation

This phase of the program included the design, fabrication, and construction or modification of the demonstration booths. Also included was a second series of booth characterization studies performed immediately prior to any construction to confirm that booth operations did not change significantly after the baseline.

Phase III - Recirculation/flow partition system demonstration testing

The third and final phase of the demonstration program was the characterization and evaluation of the performance of the recirculation/flow partition systems installed on each of the paint spray booths. The performance characterization activities included assessing the health and safety aspects of the recirculation system and establishing the capability of a technologically innovative safety monitoring system using Fourier transform infrared detector technology.

Results and Conclusions

1. In non-recirculating paint spray booths, the presence of hazardous constituent compounds in the vicinity of the operator is attributed to the air flow conditions in the booth, the target configuration, and the spray pattern created by the paint application process. These conditions create a cloud of overspray around the painter which often creates conditions in the vicinity of the painter in which OSHA factors can exceed unity. The Phase III evaluations of this program demonstrated that recirculation based on the design of this program does not cause a deterioration of working conditions in the booth. The working conditions were approximately equivalent to, although somewhat better than, the pre-modification booth environment. Thus, since the booth showed no degradation of booth environment from the pre-modification conditions, it was concluded that recirculation complies with the spirit of both the OSHA regulations defined in OSHA 1910.1000 and other applicable codes.
2. The test results in the Phase III demonstration study indicate that the partition heights and corresponding rate projections were correctly estimated. Sufficient concentration gradients occurred in the demonstration booths' exhaust face to warrant application of the recirculation/partitioning system design. This was indicated by the marked decrease in exhaust concentration above the 7 ft. (2.1 m) level of the booth exhaust face, indicating that the pollutant tended to concentrate and remain in the lower level of the booths.
3. The use of recirculation in the demonstration booths enabled the exhaust stream to the control system to be reduced from approximately 143,500 to 41,450 cfm (4,061 to 1,176 m³/min). This is an approximate 61% reduction in exhaust flow rate.

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The complete report consists of two volumes, entitled "Demonstration of a Paint Spray Booth Emission Control Strategy Using Recirculation/Partitioning and UV/Ozone Pollutant Emission Control," Volume I. Technical Report (Order No. PB98-124316; Cost: \$28.00, subject to change) and Volume II. Appendices A-E (Order No. PB98-124324; Cost: \$49.00, subject to change)

The above reports will be available only from:

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